

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A variable gauge drilling apparatus comprising:

5 (a) an apparatus housing having a housing size which is suitable for insertion in a subject borehole which has a subject borehole size within a design range of borehole sizes;

10 (b) a plurality of interchangeable borehole engaging devices having different device sizes for mounting on the apparatus housing to provide the drilling apparatus with a drilling apparatus size within a range of drilling apparatus sizes, wherein the range of drilling apparatus sizes is compatible for use of the drilling apparatus within the design range of borehole sizes; and

15 (c) a universal borehole engaging device mount located on the apparatus housing, wherein the mount is configured to accept for mounting any one of the plurality of interchangeable borehole engaging devices.

20 2. The drilling apparatus as claimed in claim 1 wherein the mount is comprised of a pocket defined by an exterior surface of the apparatus housing.

25 3. The drilling apparatus as claimed in claim 2 wherein the plurality of interchangeable borehole engaging devices is comprised of a plurality of interchangeable rotation restraining devices and wherein each of the plurality of interchangeable rotation restraining devices is comprised of a rotation restraining assembly for mounting in the pocket.

4. The drilling apparatus as claimed in claim 3, further comprising a securing mechanism for securing the rotation restraining assembly in the pocket.

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5. The drilling apparatus as claimed in claim 4 wherein the rotation restraining assembly is comprised of an assembly housing and a rotation restraining member connected with the assembly housing.

5 6. The drilling apparatus as claimed in claim 5 wherein the assembly housing has an assembly housing size and wherein the assembly housing size defines the device size.

7. The drilling apparatus as claimed in claim 5 wherein the rotation restraining member is comprised of a plurality of rollers.

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8. The drilling apparatus as claimed in claim 7 wherein the rotation restraining member is capable of movement between a retracted position and an extended position.

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9. The drilling apparatus as claimed in claim 8 wherein the rotation restraining assembly is further comprised of a biasing device for biasing the rotation restraining member toward the extended position.

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10. The drilling apparatus as claimed in claim 4 wherein each of the plurality of interchangeable rotation restraining devices is comprised of a plurality of rotation restraining assemblies and wherein the mount is comprised of a plurality of pockets.

11. The drilling apparatus as claimed in claim 4 wherein the securing mechanism is comprised of at least one fastener.

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12. The drilling apparatus as claimed in claim 11 wherein the securing mechanism is comprised of a plurality of fasteners.

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13. The drilling apparatus as claimed in claim 4 wherein the securing mechanism is comprised of at least one underlying surface on the rotation restraining assembly and at least one complementary overlying surface on the mount.

14. The drilling apparatus as claimed in claim 13 wherein the securing mechanism is comprised of a plurality of underlying surfaces on the rotation restraining assembly and a plurality of complementary overlying surfaces on the mount.

5 15. The drilling apparatus as claimed in claim 14 wherein the mount is further comprised of an axially movable member positioned on the apparatus housing and wherein the axially movable member is axially movable in a securing direction toward a securing position in which the axially movable member overlies the rotation restraining assembly so that one of the plurality of overlying surfaces on the mount is comprised of the axially movable member.

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16. The drilling apparatus as claimed in claim 15 wherein the axially movable member is comprised of a ring which surrounds the apparatus housing.

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17. The drilling apparatus as claimed in claim 15 wherein one of the plurality of underlying surfaces on the rotation restraining assembly is comprised of an overcut angular surface on the rotation restraining assembly and wherein one of the overlying surfaces on the mount is comprised of a complementary undercut angular surface on the mount.

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18. The drilling apparatus as claimed in claim 17 wherein the securing mechanism is further comprised of an urging mechanism for urging into engagement the overcut angular surface and the undercut angular surface.

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19. The drilling apparatus as claimed in claim 18 wherein the urging mechanism is comprised of the axially movable member and wherein the overcut angular surface and the undercut angular surface are urged into engagement by axial movement of the axially movable member in the securing direction.

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20. The drilling apparatus as claimed in claim 19 wherein the axially movable member is comprised of an urging shoulder for engaging the rotation restraining assembly and wherein the urging mechanism is comprised of the urging shoulder.

21. The drilling apparatus as claimed in claim 20 wherein each of the plurality of interchangeable rotation restraining devices is comprised of a plurality of rotation restraining assemblies and wherein the mount is comprised of a plurality of pockets.

5 22. The drilling apparatus as claimed in claim 21 wherein the axially movable member is comprised of an abutment ring which surrounds the apparatus housing and a locking ring which surrounds the apparatus housing.

10 23. The drilling apparatus as claimed in claim 22 wherein the abutment ring is axially positioned between the locking ring and the rotation restraining assembly.

24. The drilling apparatus as claimed in claim 23 wherein the abutment ring is slidably positioned on the apparatus housing and wherein the locking ring is threadably connected with the apparatus housing.

15 25. The drilling apparatus as claimed in claim 24 wherein the abutment ring is relatively more deformable than both the rotation restraining assembly and the locking ring.

20 26. The drilling apparatus as claimed in claim 24 wherein the abutment ring is comprised of at least one arm extending axially in the securing direction such that when the axially movable member is in the securing position, at least a portion of the arm is axially aligned with at least one of the plurality of rotation restraining assemblies so that rotation of the abutment ring relative to the apparatus housing is inhibited by at least one of the plurality of rotation restraining assemblies.

25 27. The drilling apparatus as claimed in claim 26 wherein each of the plurality of pockets is axially aligned.

30 28. The drilling apparatus as claimed in claim 27 wherein the abutment ring is comprised of a plurality of arms extending axially in the securing direction such that when the

axially movable member is in the securing position at least a portion of each of the arms is axially aligned with each of the plurality of rotation restraining assemblies.

29. The drilling apparatus as claimed in claim 27 wherein each of the plurality of 5 rotation restraining assemblies is comprised of an assembly housing and a rotation restraining member connected with the assembly housing.

30. The drilling apparatus as claimed in claim 29 wherein the assembly housing has an assembly housing size and wherein the assembly housing size defines the device size.

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31. The drilling apparatus as claimed in claim 29 wherein each of the rotation restraining members is comprised of a plurality of rollers.

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32. The drilling apparatus as claimed in claim 31 wherein each of the rotation restraining members is capable of movement between a retracted position and an extended position.

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33. The drilling apparatus as claimed in claim 32 wherein each of the plurality of rotation restraining assemblies is further comprised of a biasing device for biasing the rotation restraining members toward the extended position.

34. A method for assembling a variable gauge drilling apparatus for insertion in a subject borehole, wherein the subject borehole has a subject borehole size within a design range of borehole sizes, the method comprising the following steps:

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(a) selecting an apparatus housing having a housing size which is suitable for insertion in the subject borehole;

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(b) selecting a selected rotation restraining device from a plurality of interchangeable rotation restraining devices having different device sizes so that the selected rotation restraining device will provide the drilling apparatus with a

selected drilling apparatus size within a range of drilling apparatus sizes, wherein the range of drilling apparatus sizes is compatible for use of the drilling apparatus within the design range of borehole sizes and wherein the selected drilling apparatus size is compatible for use of the drilling apparatus within the subject borehole; and

5 (c) mounting the selected rotation restraining device on the apparatus housing using a universal rotation restraining device mount located on the apparatus housing.

10 35. The method as claimed in claim 34 wherein the apparatus housing is selected so that the housing size is smaller than the borehole size to an extent sufficient to prevent blockage of a clearance space between the apparatus housing and the borehole during use of the drilling apparatus.

15 36. The method as claimed in claim 34 wherein the selected rotation restraining device is selected so that the selected drilling apparatus size is approximately equal to the borehole size.

20 37. The method as claimed in claim 34 wherein the selected rotation restraining device is selected to provide a selected drilling apparatus size such that the rotation restraining device will engage the borehole during use of the drilling apparatus to inhibit rotation of the apparatus housing relative to the borehole.

25 38. The method as claimed in claim 34, further comprising the following steps:

30 (d) selecting a second selected rotation restraining device from the plurality of interchangeable rotation restraining devices having different device sizes so that the second selected rotation restraining device will provide the drilling apparatus with a second selected drilling apparatus size which is compatible for use of the drilling apparatus within a second subject borehole, wherein the second subject

borehole has a second subject borehole size which is within the design range of borehole sizes but which is different from the subject borehole size; and

- 5 (e) mounting the second selected rotation restraining device on the apparatus housing using the universal rotation restraining device mount.